Evaluation of the toxicity of TiO_2 and $CoFe_2O_4$ nanoparticles towards aquatic fungal communities [P4/09]

Marta Fernandes [1,2,3], Arunava Pradhan [1,2], Pedro Martins [2,3], Cláudia Pascoal [1,2], Senentxu Mendéz [2,3], Fernanda Cássio [1,2]

[1] Centre of Molecular and Environmenal Biology (CBMA), Department of Biology, University of Minho, Braga, Portugal
[2] Institute for Science and Innovation for Bio-sustainability, University of Minho,Braga, Portugal
[3] Electroactive Smart Materials (ESM), Department of Physics, University of Minho, Braga, Portugal

The exponential development in nanotechnology-based industries in recent years has accelerated the pace of the production and use of the nanomaterials. With the rapid use of nanoparticles, the natural water is likely to serve as reservoir for the nanomaterials discharged into the environment, leading to an even greater concern with respect to their interactions with the aquatic biota and associated ecosystem processes. Aquatic fungal communities play a key role in stream detritus foodweb by transferring carbon and energy from plant-litter to higher trophic levels. The impacts of TiO_2, doped TiO_2 and $CoFe_2O_4$ nanoparticles (NPs), were assessed by exposing microbially colonized leaves to 5 concentrations (0.25, 1, 10, 50 and 150 mg L^{-1}) of NPs in microcosms. Leaf decomposition rate and fungal biomass were not affected significantly by the tested NPs. However, fungal reproduction (as spore production) was affected by all NPs. The sporulation rate significantly decreased at the higher concentrations of NPs, but more pronouncedly when exposed to TiO_2 NPs (non-doped). The antioxidant enzymes involved in the ascorbate-glutathione cycle showed similar response patterns. The activities of catalase (CAT), glutathione peroxidase (GPx) and glutathione S-transferase (GST) increased in a dose-dependent manner indicating NP-induced oxidative stress. However, the responses of these stress biomarkers were stronger against TiO2 NPs (non-doped) and least pronounced against the doped TiO_2 NPs. This indicates that the doped TiO_2 NPs were the less toxic among the all tested NPs towards aquatic fungal communities.

Keywords: TiO_2 and doped TiO_2 NPs, CoFe2O4 NPs, aquatic fungal communities, oxidative stress, antioxidant enzymes

Proteomic responses to nanoparticulate and ionic silver in aquatic fungi [P4/10]

Diana Barros [1,2], Arunava Pradhan [1,2], Cláudia Pascoal [1,2], Fernanda Cássio [1,2]

[1] Centre of Molecular and Environmental Biology, Department of Biology, University of Minho, 4710-057 Braga, Portugal
[2] Institute for Science and Innovation for Bio-sustainability, University of Minho, 4710-057 Braga, Portugal

Enhanced use of silver nanoparticles (AgNPs) has inevitably resulted in their release into aquatic environments raising concern about the risk to aquatic biota and related ecological functions. Functional proteomics is an emerging technology that provides high-throughput analyses augmenting measurements of direct and highly sensitive responses at the cellular and sub-cellular levels. The impacts of AgNPs and its ionic precursor (Ag+ in AgNO3) at low exposure concentrations (close to environmental realism) on a fungal strain isolated from a non-polluted stream were assessed based on the variations in the overall proteome as well as in the activity of selected antioxidant enzymes. A total of 352 proteins were identified, but only 151 proteins were responsive (significantly up- or down-regulated relative to control) of which 65% presented matching alterations. Out of these 151 proteins, 62% increased abundance under stress induced by AgNPs and 56% under stress induced by Ag+. Exposure to both forms of silver induced proteins related to stress response, in particular, antioxidant enzymes. The antioxidant enzymatic responses were consistent with the proteomic responses, suggesting that the ability to initiate an efficient antioxidant response is essential for the fungus to cope with Ag-induced toxicity. Moreover, several proteins involved in the metabolism of carbohydrates, amino acids and lipids were altered. This evidence may reflect the need of generating energy to support the cellular defense mechanisms. Some of the significantly altered proteins were associated with the correct folding of nascent and stress accumulated misfolded proteins or degradation of transiently denatured and unfolded proteins preventing their aggregation. Others were related to the regulation of translation suggesting a compromised protein synthesis system. Overall, the functional proteomic approach can be useful to expand the knowledge on silver-induced stress responses in aquatic fungi.

Keywords: Silver nanoparticles, stress response, functional proteomics, antioxidant enzymes, aquatic fungi